

CHAPTER-8**5G Technology and It's impacts on Agriculture 4.0**

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Introduction to 5G technology

The fifth generation of mobile networks, or 5G, offers superior connectivity as well as faster internet speed. With speeds up to one hundred times faster than 4G, 5G technology enables faster data transmission and low latency, making it ideal for applications requiring high bandwidth and dependable connectivity. The most recent wireless communication technology, 5G, has the potential to completely transform how we work, play, and live. The fifth generation, or 5G, is a major improvement in terms of connectivity, speed, and capacity.

The 5G technology provides various benefits over the 4G technology that came before it. Low latency, or the amount of time it takes for a data signal to go from its source to its destination, is one of 5G's biggest benefits. One millisecond of latency is possible with 5G, which is ten times faster than 4G. This means that real-time applications requiring quick response times, such as augmented reality, virtual reality, and driverless vehicles, can be supported by 5G technology. High bandwidth, or the volume of data that can be delivered over a network at any

given time, is a further advantage of 5G technology. 5G can provide bandwidth of up to 20 gigabits per second. This means that 5G technology can enable the transport of massive volumes of data, including complicated industrial automation systems and high-definition video. A wide range of devices, from smartphones and tablets to industrial sensors and autonomous machines, can be connected to the Internet of Things (IoT) thanks to 5G's capacity to support up to one million devices per square kilometer. Modern antennas, millimeter-wave frequency, network slicing, and other new hardware and software technologies are all essential components of 5G technology. Together, these technologies can offer wireless communication that is quicker, more dependable, and more secure.

Application Areas of 5G

5G technology has a wide range of possible uses, from consumer applications like gaming and entertainment to commercial uses like smart factories and driverless vehicles. As 5G technology develops further, it is anticipated to change how we live and work by enabling higher levels of connectivity, productivity, and efficiency. The technology has the potential to improve data transmission speeds, operational efficiencies, and the level of automation in fields like agriculture and commerce.

The agricultural and commercial sectors have benefited greatly from the advancements made possible by 5G technology. The widespread adoption of 5G technology has the potential to revolutionize commercial enterprises and the agricultural industry. This article dives into the possible uses and pitfalls of 5G technology in the commercial and agricultural sectors.

Agriculture industry and 5G

Agriculture is one of the most significant economic foundations in a country's economy. Agriculture is the primary source of food for all living things on Earth. Systemic crop plant development through the integration of modern technological advancements has the potential to reduce the looming disasters of food security and hunger danger. Smart agriculture, precision agriculture, 5G, and IoT technological integration can increase farm practices to

the level of automation that can create a decision-support system to optimize operations.

Here are some specific examples of how 5G is being used in agriculture:

- **Drones:** 5G-enabled drones can be used to survey crops, monitor livestock, and apply pesticides and fertilizers. This can help farmers to save time and money, and to improve the quality of their crops.
- **Robotics:** 5G-enabled robots can be used to harvest crops, milk cows, and feed livestock. This can help farmers to reduce the amount of labor they need, and to improve the efficiency of their operations.
- **Artificial intelligence:** 5G can be used to power artificial intelligence (AI) applications that can help farmers to make better decisions about their crops and livestock. For example, AI can be used to identify pests and diseases early, and to recommend the best course of action to treat them.

Agriculture 4.0 and smart farming

The revolution of agriculture due to use of technology is considered as Agriculture 4.0 or digital agriculture (DA)[3] implies knowing its evolution through time (see figure 1)[1]. The main goal of smart farming (SF) is to increase crop quality and output by combining the use of various technological technologies with the adoption of sound agricultural practices. Examples of applications include the monitoring of disease during planting and the management of agricultural factors [8]. Its goal is to increase productivity, output, profitability, and environmental impact reduction through the use of various techniques like intelligent irrigation and careful pesticide and fertilizer application.[4]. SF combines various technical advancements, such as AI, big data, and IoT. These aid in addressing the issues and difficulties that the agricultural sector is currently dealing with, particularly the need for increased food production brought on by the rising global population, which the UN projects will total 8.5 billion by 2030, 9.7 billion in 2050, and 11.2 billion by 2100[6]. Reducing the digital divide in rural areas, which is

typically associated with low economic levels, is another problem for SF.

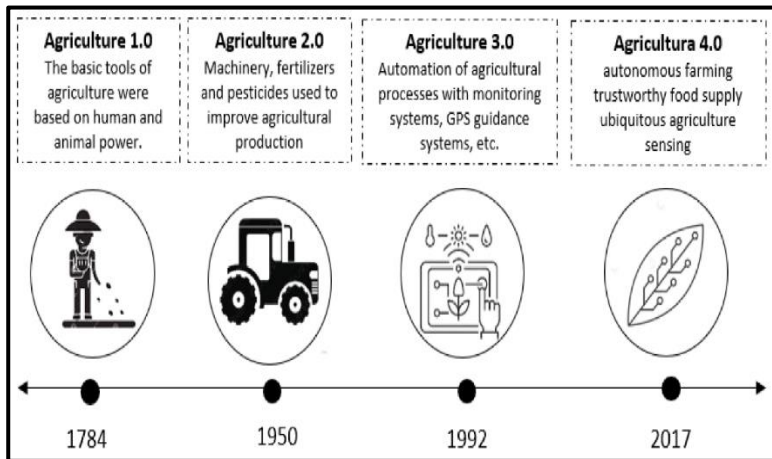


Figure 1: Revolution in agriculture [1]

According to estimates, 40 percent of the world's population resides in developing nations. By advocating for the rural population and encouraging private sector and governmental policies to increase efficiency and agro-industrial output, SF would lead to significant changes in social and economic structures [3][10]. The effective management of water, a crucial resource in agriculture, is another significant concern for SF. 70% of the freshwater used in the globe is used for this activity, while 20% of all agricultural land is irrigated.[11]

The application of technology has significantly benefited the agriculture industry. The incorporation of technology into agriculture has allowed producers to increase productivity, decrease waste, and reduce environmental impact. 5G technology offers the agricultural sector numerous opportunities, including.

1. Precision cultivation,
2. Livestock monitoring,
3. Agriculture warehousing,
4. Supply chain management and
5. Dairy business

1. Precision framing

Precision farming is a type of farming in which technology is used to enhance agricultural yields, reduce waste, and raise profitability [1]. Precision agriculture collects data on soil moisture, temperature, and nutrient levels, among other things, using sensors, drones, and other technology. This data is then utilized to make informed decisions about crop planting, fertilization, and harvesting. Precision farming can be aided by the use of 5G technology, which provides high-speed.[7]

Precision farming entails collecting data on soil moisture, temperature, and nutrient levels using sensors, drones, and other technology. This information is then examined to determine the best time to plant, fertilize, and harvest crops. Precision farming can also be used to control pests and illnesses, monitor animals, and save money on water and fertilizer.

The incorporation of 5G technology in precision farming has the potential to change the business by enabling real-time data transfer and analysis through quicker and more reliable connectivity. This can result in better efficiency and precision in farming operations, leading in higher yields and less waste.

in precision farming, the capacity of collecting and analysing data in real-time is one of the most important advantages of 5G technology [5]. Sensors and drones can transfer data rapidly to a central database through 5G's low latency and high bandwidth, allowing farmers to make sensible choices. This is especially significant when crops are at risk of harm due to weather or pests, as farmers can respond quickly to reduce the damage.

5G technology also permits the application of more advanced technologies in precision farming, such as machine learning and artificial intelligence (AI). Machine learning algorithms can analyse massive volumes of data from sensors and other sources in order to detect patterns and make decisions.

2. Livestock monitoring and warehouse management

Livestock monitoring is an essential aspect of modern animal husbandry, enabling farmers to track the health, behaviour, and location of their animals. Traditionally, livestock monitoring has relied on manual observation, which can be time-consuming and subjective. The integration of 5G technology in livestock monitoring presents an opportunity to improve the efficiency and accuracy of monitoring systems, providing real-time data transfer and analysis, and enabling greater automation and predictive analytics.[2]

More recently, technology such as sensors, GPS, and RFID has been used to automate monitoring and collect data on the behaviour and health of livestock. This data can then be used to improve animal welfare, prevent disease, and increase productivity. The integration of 5G technology in livestock monitoring can provide several benefits to farmers and animal welfare NGOs. This can be particularly important in situations where animal health is at risk, as farmers can respond immediately to mitigate the damage.

Machine learning algorithms can analyse vast amounts of data collected from sensors and other sources and transmitted via 5G to identify patterns and make predictions about animal health and behaviour. This can enable farmers to anticipate and prevent potential health issues at early stages and improving animal welfare and productivity.

Another area where 5G technology can improve livestock monitoring is in the area of automation. These systems can be used to monitor large areas of land and livestock, improving the efficiency of monitoring and reducing labour costs. This can enable farmers to anticipate and prevent potential health issues, improving animal welfare and productivity.

In conclusion, the integration of 5G technology in livestock monitoring presents an opportunity for farmers to improve the efficiency and accuracy of monitoring systems, providing real-time data transfer and analysis, and enabling greater automation and predictive analytics. With faster and more

reliable connectivity, greater automation, and enhanced predictive analytics, farmers can improve animal welfare, prevent disease, and increase productivity. However, the adoption of 5G technology in livestock monitoring does present some challenges, requiring farmers to invest in new technology and infrastructure while ensuring the security and privacy of sensitive livestock data.

3. Agriculture warehousing

Agriculture warehousing plays a crucial role in ensuring that crops and produce are stored in optimal conditions, protecting them from damage, and extending their shelf life. The integration of 5G technology in agriculture warehousing can provide several benefits, including real-time monitoring of conditions, increased automation, and predictive analytics.

Traditionally, agriculture warehousing has relied on manual monitoring of environmental conditions such as temperature, humidity, and light. This can be time-consuming and subjective, leading to sub-optimal storage conditions and product damage. More recently, technology such as sensors, automation systems, and data analytics has been used to automate monitoring and improve the quality of storage conditions.

The integration of 5G technology in agriculture warehousing can provide several benefits, including faster and more reliable connectivity. With the low latency and high bandwidth of 5G, sensors and other monitoring devices can transmit data instantly to a central database, allowing farmers and warehouse managers to make informed decisions quickly. This can be particularly important in situations where crops and produce are at risk, as immediate action can be taken to mitigate the damage.

Another benefit of 5G technology in agriculture warehousing is increased automation. With faster and more reliable connectivity, automated systems such as robotics and drones can be used to improve the efficiency of warehouse operations. For example, robotics can be used to move and

stack pallets of produce, reducing the need for manual labour and improving safety.

Predictive analytics in agriculture warehousing can also be enabled by 5G technology. Machine learning and AI algorithms can be used to obtain patterns and trends in warehouse conditions. Farmers and warehouse managers can utilize this information to anticipate and prevent possible problems, such as spoilage or insect infestations.

Furthermore, the integration of 5G technology in agriculture warehousing can improve supply chain management. With faster and more reliable connectivity, farmers and warehouse managers can share data and collaborate in real-time, improving coordination and reducing delays. This can lead to more efficient and effective supply chains, reducing waste and improving profitability.

In conclusion, the integration of 5G technology in agriculture warehousing presents an opportunity for farmers and warehouse managers to improve the efficiency and accuracy of storage conditions, providing real-time monitoring, increased automation, and predictive analytics. With faster and more reliable connectivity, increased automation, and enhanced predictive analytics, farmers and warehouse managers can improve supply chain management, reduce waste, and improve profitability. However, the adoption of 5G technology in agriculture warehousing does present some challenges, requiring farmers and warehouse managers to invest in new technology and infrastructure while ensuring the security and privacy of sensitive data.

4. Supply chain management

The use of technology in supply chain management has become increasingly important in recent years, with businesses seeking to optimize their operations and improve efficiency. Supply chain management involves the coordination and management of all activities involved in the production and delivery of goods and services to customers. This includes managing inventory, transportation,

warehousing, and logistics. The use of technology such as sensors, RFID, and GPS has enabled businesses to track goods and manage inventory in real-time, improving supply chain visibility and reducing the risk of stockouts and overstocks. The integration of 5G technology in supply chain management presents an opportunity to further improve efficiency and accuracy, reduce costs, and enhance customer satisfaction.

Another area where 5G technology can improve supply chain management is in the area of predictive analytics. This can enable businesses to forecast demand more accurately, optimize inventory levels, and reduce lead times.

5G technology can also improve supply chain management in the area of last-mile delivery. With the ability to provide real-time connectivity to delivery vehicles and drones, businesses can optimize delivery routes and provide customers with more accurate delivery times. This can enhance customer satisfaction and reduce the risk of missed deliveries.

However, the adoption of 5G technology in supply chain management does present some challenges. One of the key challenges is the need for businesses to invest in new technology and infrastructure. This can be costly and time-consuming and may require significant changes to existing supply chain processes and systems.

In conclusion, the integration of 5G technology in supply chain management presents an opportunity for businesses to further optimize their operations and improve efficiency. With faster and more reliable connectivity, greater automation, and enhanced predictive analytics, businesses can improve inventory management, reduce costs, and enhance customer satisfaction. However, the adoption of 5G technology in supply chain management does present some challenges, requiring businesses to invest in new technology and infrastructure while ensuring the security and privacy of sensitive supply chain data.

5. Enhancement in dairy business

Dairy farming is an important sector of the global food industry, providing a significant source of protein, calcium, and other essential nutrients. The integration of 5G technology in the dairy industry can provide several benefits, including improved efficiency, increased automation, and better monitoring of animal health and welfare.

One of the most significant recent trends in the dairy industry has been the move towards precision farming. The integration of 5G technology in dairy farming can help to further enhance these trends. This can be particularly important in situations where animal health and welfare are at risk, as immediate action can be taken to mitigate the damage.

Another benefit of 5G technology in dairy farming is increased automation. With faster and more reliable connectivity, automated systems such as robotics and drones can be used to improve the efficiency of farming operations. For example, robotics can be used to milk cows, reducing the need for manual labour and improving animal welfare. This can enable farmers to anticipate and prevent potential health issues, such as disease outbreaks or nutrient deficiencies.

Furthermore, the integration of 5G technology in the dairy industry can improve supply chain management.

Challenges in adaptation of 5G in agriculture.

Although 5G technology is in high demand in India, the cost has not been finalized by service providers. In distant villages, 4G is still not working adequately. However, there are significant hurdles to the implementation of 5G technology in the agriculture sector [8]. One of the most significant problems is the requirement for farmers to invest in new technology and infrastructure. This can be expensive and time-consuming, and it may necessitate major adjustments to existing livestock monitoring systems.

Another problem is the necessity for farmers to protect and safeguard critical livestock data. The increased connectivity

provided by 5G technology may increase the risk of cyberattacks and data breaches, necessitating the implementation of comprehensive security measures to secure animals and data.

However, there are several challenges to integrating 5G technology in agricultural storage. One of the most serious challenges is the need for farmers and warehouse managers to invest in new technology and infrastructure. This can be costly and time-consuming, and it may need significant changes to existing storage systems.

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